Space Weather Technical Forecast

Issued on Tuesday, 05 April 2022 at 01:18 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Minor/Moderate G1/G2 geomagnetic storm likely midweek UTC from a centre-disc filament eruption on 03 April. A second such event on 04 April is awaiting imagery.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours. The largest flare of the period as recorded by GOES 16 was a protracted event that peaked around C3.1 at 04/0743UTC. The source was over the northwestern limb, but likely corresponds to the vicinity of Ex-2976 or Ex-2975.

There are currently up to five sunspots on the visible disc, with four of these numbered and with an additional small bipolar region developing in the second half the UTC day in the southeastern quadrant. The largest region on the disc is AR2978, which retained a similar Ehi/Beta classification to recent days, with minor intermediate spot proliferation. To its immediate south, AR2981 showed a declining trend, finishing the 24 hours as a Cro/Beta. This left two small unipolar Hsx groups in the eastern solar hemisphere as the only other residents of the disc, with both stable and unremarkable.

At 04/2113UTC a filament eruption occurred in the south central disc, with this event visible in images such as AIA304 as well as Cerro Tololo H-Alpha amongst others. This event was tied to a C2.7 flare, and given its central location may well carry an Earth-directed component. This will be analysed as and when coronagraph imagery becomes available, with updates to follow. With the caveat that the above event remains unaccounted for, three CMEs were in evidence in available coronagraph imagery for the UTC day of Monday 04 April. These three have been modelled and carry no Earth-directed component.

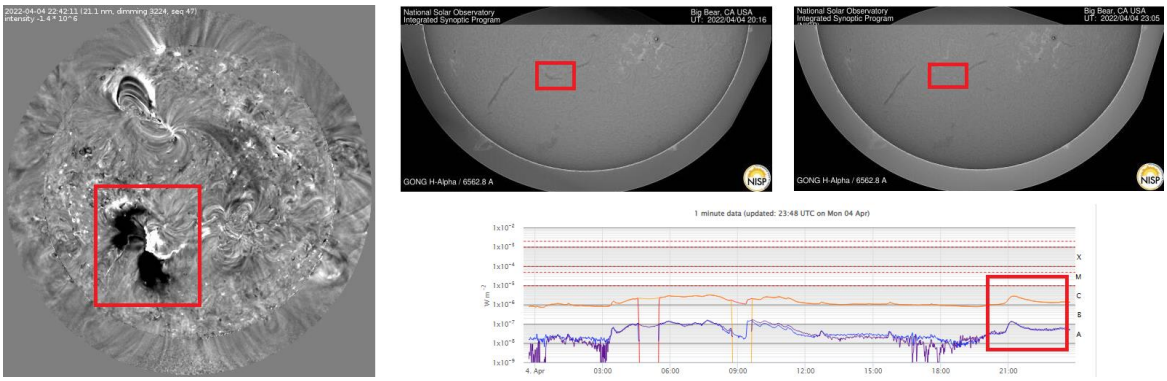


Figure 0: Clockwise from left: time-integrated AIA 211 image showing boxed red dimming from 04/2100UTC filament eruption near centre-disc. Also shown are Big Bear H-Alpha images before and after the event, as well as GOES 16 X-ray flux for the period. Coronagraph imagery is not yet available to determine if there has been any Earth-directed CME, with updates to follow.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was perhaps symptomatic of a stubborn connection with a negative polarity high speed stream, probably that from CH70, however it underwent occasional resurgences in speed and brief dalliances with a positive phi angle, perhaps indicating the connection is tenuous or that Earth is skirting the northern edge of its influence. The solar wind speed showed an erratic overall downward trend, falling from the low-500s of km/s to reach 450km/s. The solar wind density was within its typical background range of mid-single figures ppcc, while the IMF showed an overall sight decline from an early high of 8nT. The north-south component varied between -6 and +3nT, although this was often aligned southward to some degree. The phi angle was mainly negative (towards the sun), but occasional deviation into a positive sector was seen during the early hours UTC.

The net result of the above solar wind measures was somewhat erratic, in tandem with the character of the wind, with Quiet to Active intervals observed, provisionally peaking with two successive intervals of Kp '4-' at 00-03 and 03-06UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES-16 showed a continuing gradual relaxation towards Background levels, having reached S1/Minor Storm on 02 April, in the wake of an M-class flare from the northwest limb.

The high energy (greater than 2MeV) electron flux as observed by GOES-16 at GEO showed a restive and slightly increased-amplitude diurnal oscillation between Normal Background and High flux, peaking at 3920pfu at 03/1645UTC. The 24-hour integrated fluence showed a relatively flat trend throughout, just shy of Active fluence and with 8.64e7 integrated pfu recorded at 05/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity should be predominantly Low, with relatively fewer and less complex active regions on the visible disc than of late.

Solar Wind / Geomagnetic Activity: The current coronal hole high speed stream is the only one in the forecast, and an exit to a slow wind regime is expected for day one, Tuesday 05 April, with geomagnetic activity then largely Quiet in the absence of transients.

There is one confirmed CME in the forecast at present, that from the 03/1500UTC filament eruption. This is due to arrive around 06/1200UTC, with the Likely result of a Minor or Moderate G1/G2 geomagnetic storm intervals, perhaps continuing into the start of Thursday 07 April.

In addition to this confirmed CME, a second centre-disc filament eruption observed to peak around 04/2100UTC has yet to be analysed but may well also feature in the forecast, with updates to follow as and when imagery becomes available.

Energetic Particles / Solar Radiation: The risk of further solar radiation storms should now slowly reduce as last week's highly active northwestern sunspot regions rotate further onto the far side. The residual risk from current front side groups is much lower given their quiescent behaviour.

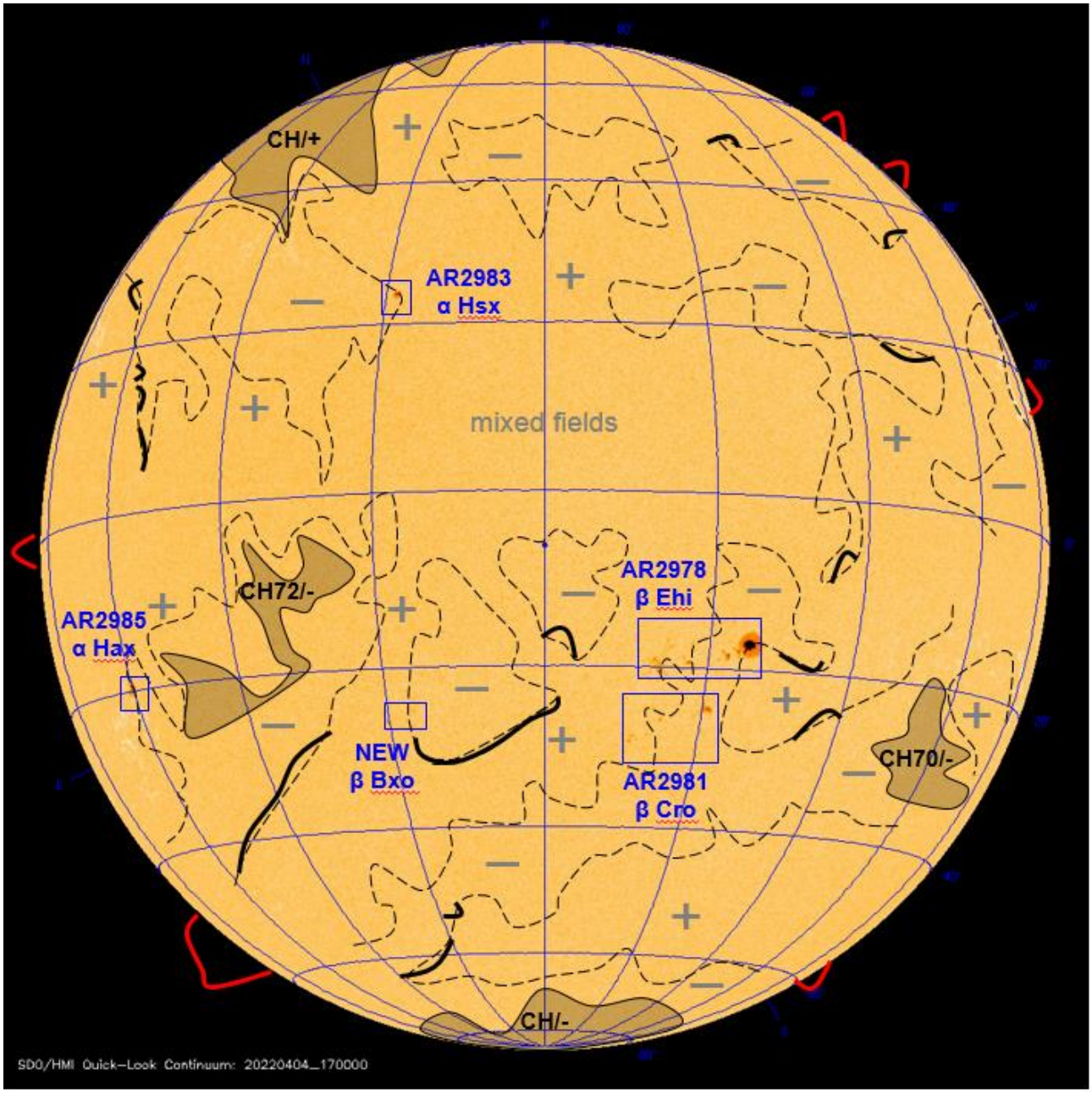
The high energy (greater than 2 MeV) electron flux may show a slight day-on-day increase in the immediate term, in the wake of recent fast wind influence. The chances of Active fluence are marginal through to midweek, but again perhaps slightly more likely than not to occur. Flux levels may then be attenuated by the 03/1600UTC CME arrival, which is currently expected to arrive at Earth midweek UTC. Any recovery in fluence following this will probably be insufficient to breach Active. Note that there is one possible unassessed CME candidate discussed above

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

that may affect this forecast.

Figure 1. Solar Analysis Valid 04/1700UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

The current connection to a negative polarity high speed stream is the only likely coronal hole influence in the four-day period. Solar winds have been relatively restive in the past 48 hours or so, with frequent minor resurgences perhaps surprising given the apparently minor CH71 and CH70. The erratic traces may be reflective of peripheral influence of these features and a fickle connection, however a decline to a slow solar wind environment should resume in earnest in the first forecast interval to leave mainly Quiet conditions thereafter, transients excepted.

There is one confirmed CME in the current forecast and one likely one pending assessment. The 03/1500UTC filament eruption formed a full halo in available coronagraph imagery, and can be expected to arrive within the UTC day of Wednesday 06 April, with a Chance of effects ongoing into Thursday 07 April. G1/G2 Minor or Moderate storms are Likely.

This forecast will be updated as and when any confirmed imagery and modelling has been conducted on the 04/2100UTC filament eruption, although its central location would point at likely Earth-based effects should it have left the immediate solar environment.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	70	30	1
Strong	G3	No	1	5	2	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

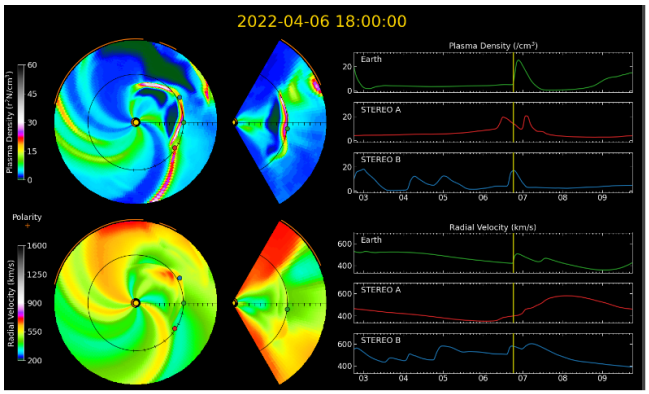
Geomagnetic Activity - Earthbound Coronal Mass Ejections

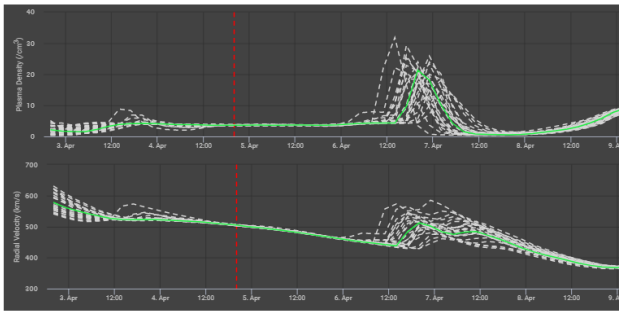
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/04/2022 21:13	Full	Filament eruption	Cenre-SW quadrant	595	06/1800UTC	Onset likely within second half of UTC day.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: Latest MOSWOC Enlil and ensemble, showing a slightly delayed arrival of the 03/1500UTC filament CME relative to earlier guidance, although with onset still falling within the UTC day of 06 April.





Radio Blackouts - X-Ray Flares:

The sun now appears to show an overall waning in X-ray activity, particularly given the departure from the Earth-facing side of Ex-AR2975 and to a lesser degree Ex-AR2976. This has left a disc populated by quiet unipolar groups and the large, but quiet and fading AR2978 and AR2981 near centre-disc.

There are numerous bright flux regions hinted at in STEREO A EUVI 195 imagery just shy of the eastern solar horizon. These may offset the departing regions to some degree, however these will be analysed in due course and do not yet feature in the forecast.

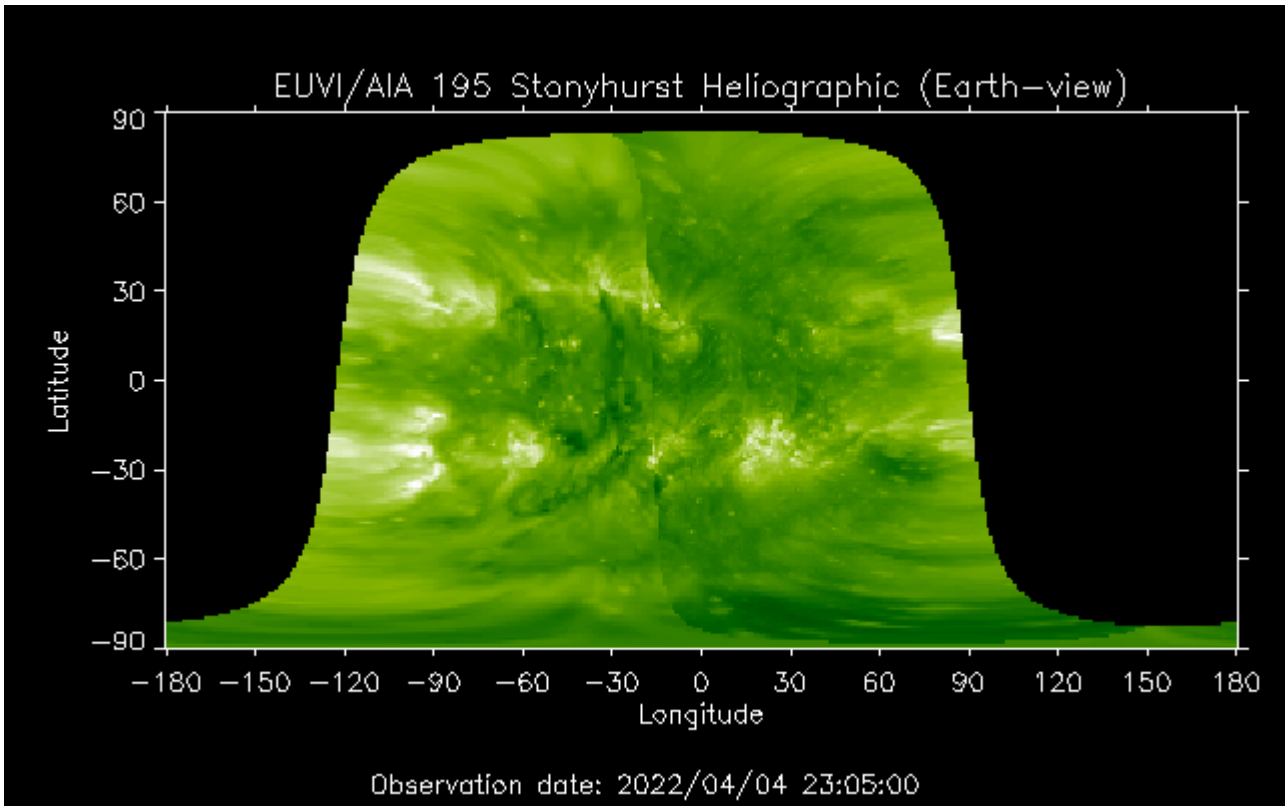
Overall, the chances of significant X-ray flares are much-reduced relative to the recent past. M-class flares are rated at a daily Slight Chance throughout, largely the result of the raw potential of AR2978, although this has not been borne out in its activity, and the probabilities may yet be reduced further.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 3: Cylindrical projection of the sun in EUVI 195, showing bright flux regions lying on the eastern solar horizon. These may counter the recent reduction in flare risk when they rotate onto the disc.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is now well below the S1/Minor Storm threshold but remains slightly above resting background levels. This is expected to now very soon decline to its background state.

The source of all the recent S1 and near-S1 level enhancements (Ex-AR2975) rotated around the northwest limb late on Sunday 02 April, and as such its contribution to the risk of further such events should lessen. The residual risk of S1 should then be inherited by the westward advance of the large but relatively subdued AR2978 and AR2981, perhaps offering a lower ongoing risk later this working week (UTC).

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	15	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: Past 72 hours in GOES 16 high energy proton flux (top), showing gradual decline from S1 reached in wake of M3.9 flare from Ex-2975 on 02 April. The chances of similar such occurrences are now reducing.

High Energy Electrons Event (≥ 2MeV):

High energy electron flux showed a slight diurnal increase in its oscillation over the UTC day of Monday 04 April, although the character was a little erratic in tandem with the behaviour of the solar wind. Flux levels have proved unusually resilient to recent observed Active Kp, and a slight increase in observed levels towards midweek cannot be ruled out, especially as geomagnetic activity should now reduce as CH70 weakens further. As with recent forecasts, 24-hour integrated fluence may just exceed Active until the arrival of the 03/1500UTC CME around 06/1200UTC, with the added caveat of a second unassessed CME lowering confidence in the electron forecast still further.

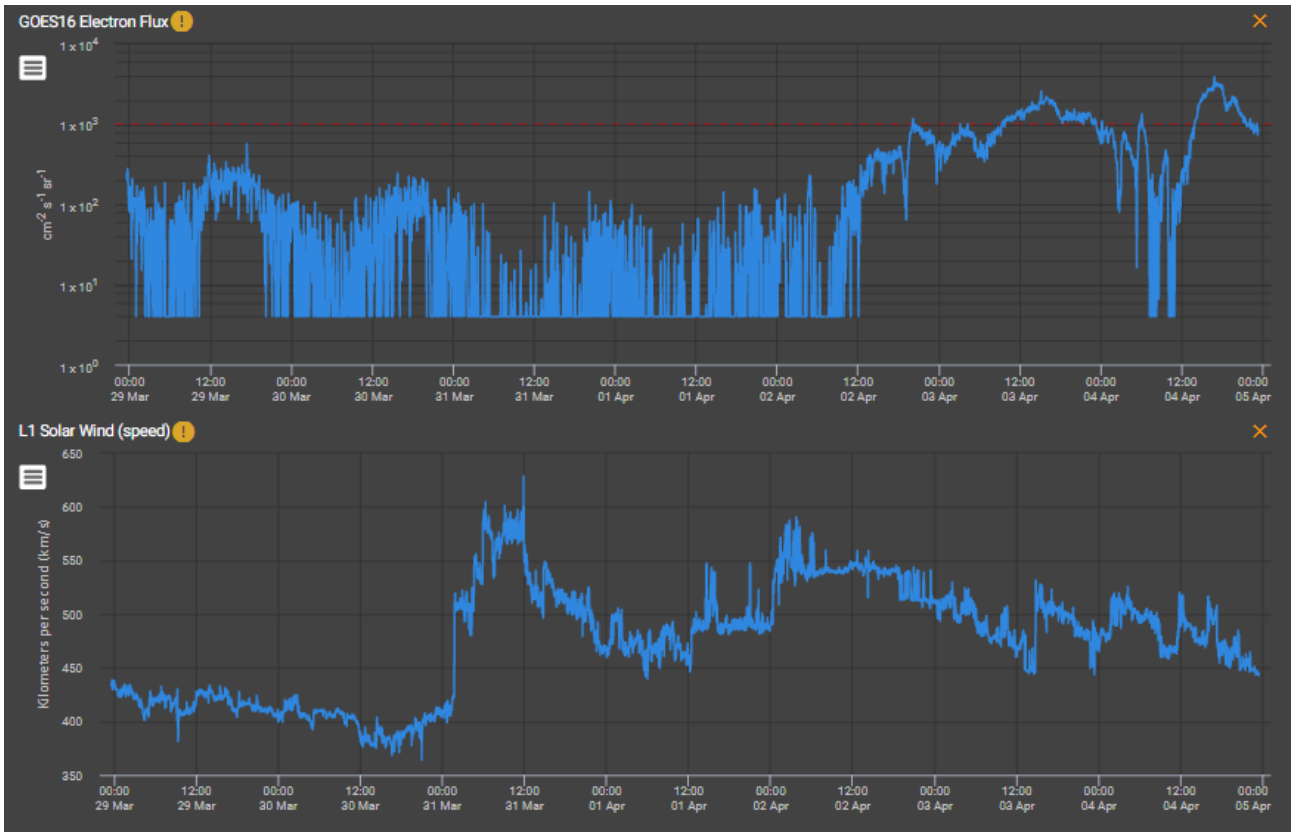
It is felt that current flux levels may not be repeated in the less supportive solar wind environment that should surround these possible transients, and the overall risk of Active therefore shows a step-wise fall after midweek UTC.

GEO Electron Environment / **Probability (Exceedance)**	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)** (%)	**Day 2 (00-24 UTC)** (%)	**Day 3 (00-24 UTC)** (%)	**Day 4 (00-24 UTC)** (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	60	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 5: The past week in GOES 16 high energy electron flux (greater than 2MeV, top), and the causative L1 solar wind speed as measured by DSCOVR (below). A slight increase is possible before CME activity arriving midweek.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.